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## PROPOSAL FOR ACCURATE CALCULATION
## OF CHINESE RR TRANSPORT PERFORMANCE

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### A.    Purpose of Proposal

Railway transport performance is the collective result of the performance of all departments of a railway. It is directly related to transport capacity, transport efficiency, transport schedules, transport volume, and transport costs. The question of how to make the appraisals and computations by which to obtain firm uninvolved results, which take all the necessary factors into account, is an important and complicated one.

One fairly satisfactory way of readily securing a measurement of the efficiency of freight-car usage is to compute the carloads, average turnaround time, and the tonnage of goods carried. Whether or not to include the factor of mileage /although Chinese railways operate on the kilometer system, the term miles and mileage are used in this article for the sake of brevity/ is a question. The two basic factors that should be included in evaluating transport performance are the above-mentioned data and the mileage. Hitherto, carloads and tonnage figures have not taken mileage into account. But even if mileage were taken into account in reckoning the average turnaround time, (because the more mileage, the longer the turnaround time), this would not by itself make it possible to calculate with accuracy the working efficiency of freight transportation.

Beside the working efficiency, there are other factors such as train mileage, daily number of trains in opposite directions, percentage of train punctuality, degree of proper use of locomotive power, empty-locomotive-mileage, train and traffic accidents, passenger-mileage, and (freight) ton-mileage income from passenger and freight traffic, transport costs, etc. All these factors must be taken into account to secure final figures for comparing the transport efficiency of one period with that of another period, or of one railway bureau with that of another bureau. Hence, the problem in what is called transport performance is how it is to be calculated.

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On the one hand, all factors and items related to the subject should be given consideration to get a complete picture, and on the other hand, the factors should be logically analyzed and differentiated into those that should enter into the computations and those that should be ignored to avoid repetition and confusion. To this end, the following form of record and method of calculation is suggested.

B.  Chart for Recording Transportation Performance Data

/See chart on following page./

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## CHART FOR RECORDING TRANSPORTATION PERFORMANCE DATA

.....................Bureau   For Month Ending..........19..

| Item No | | | | I | II | III | IV | V | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | | **Capacity** | | | | | | | |
| 1 | Train-mileage (kilometrage) | | | 8 | | | | | |
| 2 | | Pass train-mileage | | 2 | | | | | |
| 3 | | Frt " " | | 6 | | | | | |
| 4 | Average No of two-way trains daily | | | 2 | | | | | |
| 5 | | Pass trains " | | 1 | | | | | |
| 6 | | Frt " " | | 1 | | | | | |
| 7 | Mileage per pass car | | | 2 | | | | | |
| 8 | Mileage per frt car | | | 8 | | | | | |
| | | **Efficiency** | | | | | | | |
| 9 | Frt | Mileage per car per day | | 8 | | | | | |
| 10 | cars | Av tonnage of loaded cars | | 4 | | | | | |
| 11 | | Proportion of empties | | 5 | | | | | |
| 12 | Frt trains | Percent not used of total locomotive hauling power | | 4 | | | | | |
| 13 | Frt trains | Percentage of unloaded locomotive mileage in total train-mileage | | 4 | | | | | |
| | | **System** | | | | | | | |
| 14 | Punctuality | Pass trains | | 6 | | | | | |
| 15 | Percentage | Frt " | | 6 | | | | | |
| 16 | No of "responsibility" accidents* per 10,000 train-miles | | | 10 | | | | | |
| 17 | No of traffic accidents per 300.000 frt car-miles | | | 3 | | | | | |
| | | **Volume of Traffic** | | | | | | | |
| 18 | Quantity | Passenger-miles | 5 | | | | | | |
| 19 | | Ton-miles | 5 | | | | | | |
| 20 | | Combined ton-miles** | | 10 | | | | | |
| 21 | Revenue | Pass receipts | 5 | | | | | | |
| 22 | | Frt receipts | 5 | | | | | | |
| 23 | | Combined receipts | | 10 | | | | | |
| | | **Statistical Breakdown** | | | | | | | |
| 24 | Combined ton-miles per RR worker** | | | 5 | | | | | |
| 25 | Traffic receipts " " " | | | 5 | | | | | |
| 26 | Totals | | | 100 | | | | | |

*Accidents for which RR workers are responsible.
**Passenger-miles and ton-miles combined on basis of equality.
I, Assigned Rating; II, Planned Goal; III, Actual Accomplishment;
IV, Percent of Accomplishment; V, Score.

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C. **Method of Computation**

1. The assignment of rates to the various factors.

As in the accompanying chart, the five important factors entering into the computation of railway transport performance, together with the standard ratings assigned to each, are as follows:

| Transport Performance | Percent |
|---|---|
| Capacity | 20 |
| Efficiency | 25 |
| System | 25 |
| Volume of traffic | 20 |
| Statistical breakdown | 10 |
| Total | 100 |

On the same principle, these standard ratings are subdivided among a number of subsidiary factors, as shown in the chart.

In the rating of these factors, the speed of trains which affects the rate of use of the cars, and the layover time of trains (including the time of the locomotive's use of the turntable), are the two which are weighted most heavily; since they have an important bearing on the car-mileage per day (or turnaround time). If the speed of travel is high and the standing time (including use of turntable or of a Y for reversal of direction) is small, then the car-mileage per day is large. This factor is rated at 8 points out of 100. Hence the car-mileage which is rated at 8 points, and the train-mileage which is rated at 6 points, are also large. Similarly, the ton-mileage which is rated at 5 points, and the revenue from goods transported which is rated at 5 points, may also be large; and vice versa. These items together amount to 32 points.

Next in importance is the rate, 12 points, for punctuality of trains. Then comes the cases of operational "responsibility" trouble and accidents which are assigned 10 points. From the number of points assigned to these two factors may be seen the degree of their influence on transport performance. The punctuality of freight trains and passenger trains are both assigned 6 points, the former because of its importance and the latter because of its difficulty. The rates assigned to the other factors also take these principles of importance and difficulty into consideration.

2. Determination of Figures for Planned Goals

The assignment of figures for planned goals depends mainly on estimates made for each month based on a combination of the factors of past performance, an objective appraisal of present conditions, and a forecast as to the future. An explanation of the method used in the determination of figures for planned goals and the methods used in computations is given below.

a. Train-Mileage

The planned number of passengers, quantity of freight, and total train-mileage, are all to be found by ascertaining the present monthly number of scheduled trains and the distances each will travel within its own /RR Bureau/ area and making computations in the same manner used in determining the monthly planned locomotive mileage.

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**b. No of Two-Way Trains per Day**

The number of planned two-way passenger and/or freight trains per day is computed by taking one half the figure of the daily average ton-mileage /one passenger-mile is treated as equivalent to one ton-mile/ of passengers and/or freight to be transported, divided by the planned average daily train-mileage for passengers and/or goods. The sum of the number of two-way passenger trains and of two-way freight trains is the total number of two-way trains. The use of this latter figure is similar to that for train-mileage; the figure for percentage of achievement should work out to be practically the same in both cases. But taken together each has its own usefulness, for train-mileage represents total figures, while the number of two-way trains indicates average figures.

**c. Passenger Train-Mileage and Freight Train-Mileage**

This item is computed on the basis of the number of passenger trains and freight trains provided for in the monthly planned goals, the mileage to be covered within the /RR Bureau/ area, and the number of cars planned for each train.

**d. Freight Car-Mileage per Day**

This is found by dividing the average total daily freight car-miles by the average number of freight cars planned to be used each day.

**e. Average Net Load for Freight Cars (Average tonnage of loaded freight cars)**

To get this figure, divide the planned total tonnage of freight loads for the month by the number of cars planned to be loaded during the month. Only pay loads should enter into this calculation.

**f. Rate of Empty Cars**

Divide the planned monthly empty-car-mileage by the planned monthly loaded-car-mileage.

**g. Percentage of Profitable Use of Locomotive Power**

Divide the planned possible tonnage which the locomotives in service are capable of handling, by the planned average tonnage of the assigned /standard/ loads of the said locomotives, and then multiply by 100. The assigned standard load tonnage should be determined in accordance with the average of the practical hauling power of the locomotives of the various railways. The possible load tonnage should be determined in accordance with past actual hauling performance of the locomotives. Conditions should be viewed objectively and the figures assigned should not be less than the minimum standards which the locomotives should properly have, on the principle that given proper efforts on the part of the crews, the planned percentage can be achieved.

**h. Percentage of Empty-Locomotive-Mileage in Total Train-Mileage**

Divide the planned empty-locomotive-mileage by the planned train-mileage for each month, and multiply by 100. This item of /planned/ empty-locomotive-mileage should be based on the past actual performance of each locomotive, objectively viewed and placed at the maximum figure that is proper, on the principle that, given proper effort on the part of the crews, the planned percentage can be achieved.

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### i. Train Punctuality Percentage

The punctuality in departure and arrival of passenger trains should be calculated separately for each train and then combined; similarly, for freight trains. In the case of passenger trains, the achievement of 100-percent punctuality in actual operation is required to be credited with the full percentage of performance. In the case of freight trains, the achievement of 90-percent punctuality in actual operation is sufficient for being credited with full percentage of performance. By common consent, the lowering or raising of these standard percentages of punctuality may be considered and sanctioned for bureaus in whose areas there are lines where traffic is unusually heavy or light.

j. Zero cases of "responsibility" accidents per 10,000 train miles, should be taken as the planned figure for this item.

k. Zero cases of traffic accidents per 300,000 loaded freight car-miles, (not counting empty cars), should also be taken as the planned figure for this item.

### l. Passenger-Miles, Ton-Miles, and Combined Ton-Mileage

The number of passenger-miles is computed by multiplying the planned number of passengers by the average distance traveled. The number of tons of cargo to be transported by the average distance transported. The combined ton-mileage is obtained by adding together the two foregoing items. The passenger-miles and ton-miles of passengers or cargo entering a given bureau's area from the outside for transportation to a destination within the area, must be included.

### m. Passenger Receipts, Freight Receipts, and Total Receipts

The figures to be used for these items in the evaluation chart are the planned potential receipts of each bureau, not the actual receipts. Similarly, with respect to through traffic from an outside area, the computed figure to which a given bureau is entitled, based on the passenger-miles or ton-miles, multiplied by the standard rates, plus the miscellaneous fees which are proper, should be used on the chart, not the actual receipts.

### n. Combined Ton-Miles per Transport Worker

The combined ton-miles, divided by the required number of indoor and outdoor transport workers within the bureau's jurisdiction gives the figure which should be used for this item in the chart. It should be arrived at on the basis of the past experience, objective conditions, and rational standards.

### o. Traffic Receipts per Transport Worker

Divide the total traffic receipts by the required number of indoor and outdoor transport workers within the bureau's jurisdiction. This is the figure which should be used for this item in the chart. It should be arrived at on the basis of past experience, objective conditions and rational standards.

The combined ton-mileage per worker, or the traffic receipts per worker, do not of themselves show what the cost of transportation is; but as unit figures (ratios) they indicate the relative degree of effect on costs of factors which do affect the cost of transportation. Thus, Item 14 serves as an indicator of high or low performance, and, indirectly, of costs from an

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operational standpoint; while Item 15, in a similar way, serves as an indicator of high or low performance, and, hence, indirectly of costs from the earned income standpoint. There is a place for both in the calculation of performance chart.

### 3. Calculation of Percentage of Performance and Earned Ratings

For each item in the chart, enter in Column No II the planned goal figure obtained in the manner already explained. In Column No III enter the figure for the corresponding actual accomplishment. Divide the figure in Column No III by the figure in No II to find the percentage of accomplishment of the planned goal and enter it in Column No IV. Multiply the assigned rating in Column No I by the percentage of accomplishment in Column No IV, and the result, to be entered in Column No V, will be the score, on the basis of 100, for this particular item. When this process has been completed for all the items, add the figures in Column No V and the total at the bottom will be the final comprehensive score of the bureau for the period (month) concerned. Take Item 1, relating to train mileage, as an illustration. Suppose the planned goal is 60,000 and the actual number is 48,000, then the degree of accomplishment is $\frac{48,000}{60,000}$ or 80 percent. Eighty percent of the assigned rating, 8, is 6.4, which is the figure to be entered in Column No V. However, in connection with certain of the items there are some particulars which need further explanation.

a. Item 16 refers to the number of cases of "responsible" accidents per 10,000 miles, for which the assigned rating is 10. Naturally it would be expected that there should be no accidents in order to get a perfect record, which is represented in Column No II as 100 percent or $\frac{100}{100}$. From this, deduct the amount $\frac{100}{100}$ for each case or fraction of accident per 10,000 ton-miles that occurs. Let us suppose that two accidents occurred in the course of 50,000 ton-miles; this would be at the rate of $\frac{40}{100}$ cases per 10,000 ton-miles. After deducting this, there is $\frac{60}{100}$ still to our credit which is the achievement percentage to be entered in Column No IV. This figure multiplied by the rating for this item, 10, gives 6, which is then the score to be entered in Column No V. According to this method of calculation, if the accident rate is one or more than one per 10,000 ton-miles, the figure to be put in Column No IV is zero and the score in Column No V will be zero.

However, it is recognized that some accidents are more serious and destructive than others. To allow for this, accidents are graded in five classes. In general, one ordinary accident is graded as one. (Under certain conditions, such as unusually bad track due to hurried repair of damage caused by military action or unusual floods, worn out rolling stock, seriously defective or entirely absent signal apparatus, two accidents may be classified as equivalent to one. In such a case, $\frac{50}{100}$ would be deducted for one ordinary accident.) Other accidents are graded as follows:

| | |
|---|---|
| Forced stopping of train, with attendant delay | 0.5 |
| Bad accident | 2.0 |
| Serious accident | 4.0 |
| Very serious accident | 8.0 |

To illustrate the method of computation, suppose that on a certain road in a given month, there occur in the course of 500,000 ton-miles of traffic, one very serious, two serious, two bad, and three ordinary accidents, and six stoppages with delays. The figure to be put in Column No III then would be found in this manner:

$$\frac{1 \times 8 + 2 \times 4 + 2 \times 2 + 3 \times 1 + 6 \times 0.5}{50,000 \div 10,000} = \frac{26}{50} = \frac{52}{100}$$

Deduct this from $\frac{100}{100}$ and the result, $\frac{48}{100}$, is the percent of accomplishment which is to be entered in Column No IV. Multiplying this by the rating, 10, the score for Column No V is 4.8.

b. Item 17 deals with the number of traffic accidents per loaded freight car per 300,000 miles. The method of computation to be used here is as follows. There is no division in grades, all are treated alike; $\frac{100}{100}$ for each traffic accident per 300,000 car-miles. Thus, one or more traffic accidents per 300,000 car-mile would mean zero accomplishment. To illustrate, suppose a certain road in a certain month had 15 traffic accidents in the course of 7,200,000 car-miles of operation, and the standard rating is 3. The accomplishment (Column No III) then is

$$\frac{15}{7,200,000 \div 300,000} = \frac{15}{24} = 0.625$$

The percentage of accomplishment (Column No IV) is $\frac{100}{100} - \frac{62.5}{100} = \frac{37.5}{100}$. The score for Column No V is then $3 \times \frac{37.5}{100} = 1.12$.

c. Care should be taken not to reckon any items twice. Note that in the chart, Item 1 is the sum of Items 2 and 3; Item 4 is the sum of Items 5 and 6; Item 20 is the sum of Items 18 and 19; Item 23 is the sum of Items 21 and 22. This means that if the scores for Items 2 and 3 are calculated separately and entered in Column No V, then the score for Item 1 should not be entered; and similarly below.

d. In view of the above, and of the fact that the standard assigned ratings for Items 2 and 3 are not the same, it is necessary to calculate their scores for Column No V separately. It would be incorrect and improper to compute the figures of Items 2 and 3 for Column No IV, add them together, and then multiply by 8.

4. Score Calculations of Different Bureaus

Here again it is important to caution each bureau, in totaling its scores for the various factors or items, not to duplicate the items specifically mentioned in Paragraphs c and d above.

Since it is possible that some bureaus may achieve unusually good records in certain items, even surpassing the planned goals or quotas, resulting in a total of more than 100 score points, it is the rule that the score for any particular item shall not exceed the standard assigned rating by more than 20 percent. For example, for Item 1, or the sum of Items 2 and 3, the score to be entered in Column No V may not be more than 120 percent of 8, or 9.6.

In the matter of decimal fractions, report only to two points of decimals, discarding any figure in the third position that is less than 5, and increasing the second figure by one if the third figure is 5 or more.

5. Method for Reckoning the All-China Total Transport Performance

In the method of reckoning planned figures and achievement figures, the figures for the entire country for any single item on the chart are found by adding the corresponding figures obtained for the individual railway bureaus. However, it is important to note that in combining the figures which are reached by dividing one figure by another figure, the dividends should first be added and then divided by the sum of the divisors. To illustrate, find the average car-mileage per day for three different bureaus. Suppose

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Bureau A has 800 freight cars working an average of 80,000 miles per day, and Bureau C has 1,200 cars working an average of 140,000 miles per day, Bureau B has 1,000 cars working an average of 140,000 miles per day.

The average car mileage per day would be

Bureau A $\quad \dfrac{80,000}{800} = 100$

Bureau B $\quad \dfrac{90,000}{1,000} = 90$

Bureau C $\quad \dfrac{140,000}{1,200} = 116.67$

The average for the three bureaus however, would be

$$\frac{80,000 + 90,000 + 140,000}{800 + 1,000 + 1,200} = \frac{310,000}{3,000} = 103.33,$$

and not the average of 100, 90, and 116.67, which is 102.22. This principle should be observed in other comparable calculations. Apart from this, calculation of other items for the entire country are similar to those for individual bureaus or individual railway lines

D. **Questions Awaiting Decision**

The foregoing proposal is still in the tentative stage, and there are points where some may feel that modifications should be made. The author invites his fellow professionals to study this matter carefully and to consider the following questions. He will welcome their suggestions as to how best to adapt these proposals to fit the conditions of the whole or major part of the country.

1. As to the factors that have an important influence on railway transportation performance, are there here any important omissions or unnecessary duplications? Is the analysis rational? Is there need for a different content and form of analysis? Could any of the items on the chart be omitted?

2. In the matter of standard assigned ratings, (Column No I), there are probably varying opinions. How should these ratings be modified so as to be more rational?

3. Are there any questions as to the method of reckoning planned goal and actual occurrence figures, especially in the items for "responsibility" accidents and/or traffic accidents?

4. In determining the planned goal figures for the various items, or factors, what basic standards should be adopted, and what procedure should be followed?

5. After the performance records have been carefully prepared and submitted, those making the best records should be selected for reward. Two methods for conferring rewards are possible. One is to reward the bureau that makes the highest score; the other is to grant a reward to all bureaus whose scores are over 90. Which way is better? What is the best kind and manner of reward?

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### E. Essential Conditions

When the foregoing questions are all fairly and definitely settled, it should be possible to devise an entirely satisfactory method for computing and evaluating the transportation performance of all the railways in the country. But, for these performance records to be accurate, their evaluations to be authoritative, and the awards to be fairly bestowed, it is essential that certain conditions should be positively assured. These are:

#### 1. Calculating Methods Must Be Uniform

Hitherto, uniformity has been lacking in the matter of punctuality. Some railways base their data on the time of arrival and departure of trains from the various railway stations; some on the time that trains pass from one railway section to another, some when trains pass the train despatcher's office, and some only when the trains pass from the area under the control of one bureau into that of another bureau. A uniform practice in this matter must be adopted.

Uniformity is also needed in recording the weight of loads carried. Some railroads base their data on true weights, some on technically made measurements, some on the figures on waybills on which freight charges are based. Here too, a uniform practice must be adopted. In addition, there must be a clearer definition of what movements of locomotives are to be included in the item "mileage of locomotives running without loads." Doubtlessly, there are other practices at variance with each other. But they all affect the figures reported. Uniformity must be achieved and guaranteed.

#### 2. Statistical Data Employed Must Be Accurate

Unfortunately, we cannot at present rely on the accuracy of our statistics. This situation must be remedied, or our calculations will be futile and valueless.

#### 3. System of Inspection Must Be Strict and Thorough

For uniformity and accuracy, it is essential that there be a strict system of inspection and checking, so that instances of departure from uniformity and inaccuracies may be immediately detected and corrected. A system of checks and counterchecks at different stages and on different levels must be instituted.

In making this proposal, the author has attempted to devise an exact method, which is both analytical and integrated, for measuring and evaluating the performance of the railways as a whole.

Due to his inexperience and unfamiliarity with the USSR's advanced system of railway administration, it is inevitable that his efforts should be far from perfect. Therefore, it is hoped that his fellow professionals will present their studies of this problem.

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